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# TECHNICAL PAPER



## INDEX TERMS

**Metrication**

**NASA METRICATION ACTIVITIES**

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## ABSTRACT

This paper covers NASA organization for metrication, NASA metrication policy, a synoptic view of NASA metrication from 1964, NASA participation in Federal Agency activities, NASA interaction with nongovernmental metrication organizations and the proposed NASA Metrication Assessment Study.

**1978**

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(NASA-TM-79522) NASA METRICATION ACTIVITIES  
 (National Aeronautics and Space  
 Administration) 3 p HC A02/MF A01 CSCI 05B

## I. INTRODUCTION

In 1977 the Society of Automotive Engineers extended an invitation to NASA to participate in the WESTEC '78 Conference which was scheduled for March in Los Angeles, California. The purpose of the NASA participation was to discuss NASA Metrication and related activities, primarily between 1976 and 1978. This paper is intended to cover six topics: (1) NASA organization for metrication, (2) NASA metrication policy, (3) a synoptic view of NASA metrication since 1964, (4) participation in Federal Agency activities, (5) interactions with non-governmental organizations, and, (6) the proposed NASA Metrication Assessment Study.

## II. NASA ORGANIZATION FOR METRICATION

The NASA Metrication Program currently is under the cognizance of the NASA Chief Engineer. He was assigned responsibility for the program by the NASA Administrator, in August, 1977. Previously, the program was the responsibility of the Assistant Administrator for Industry Affairs and Technology Utilization. However, beginning in 1976 a review of NASA metrication activities showed that 95 percent of the workload resided in the areas of engineering and the concomitant metrication of specifications, standards and related documentation. Since the NASA Chief Engineer already had been assigned responsibility for these engineering activities, it was only logical that the remaining 5 percent of the workload be assigned to the same office. Subsequently, with NASA reorganization, the Office of Industry Affairs and Technology Utilization was disestablished.

Since metrication touches upon almost every aspect of NASA programs, the following actions were swiftly taken commencing in 1976: (1) appointment of a NASA Metric Coordinator, (2) designation of metric representatives from the Headquarters Program and Staff Offices, and (3) appointment or re-appointment of Metric Coordinators at the 9 NASA Centers, the Jet Propulsion Laboratory, and the National Space Technology Laboratories (at Bay St. Louis, Mississippi).

## III. NASA METRICATION POLICY

The first formal NASA Policy Directive pertaining to metrication, NPD 2220.4, was issued in September 1970. This directive stated;

"Measurement values employed in NASA Technical Reports, Technical Notes, Technical Memoranda, Contractor Reports and Special Publications shall be expressed in the International System of Units (SI)"

Beginning in 1976 a NASA management issuance was drafted by Headquarters Metrication representatives, and staffed informally with the NASA Centers in 1977. A file of the completed draft was forwarded to the Office of the NASA Chief Engineer in January 1978. It contained many of the provisions of the guidelines for metrication policy approved by the Metrication Subcommittee of the Interagency Committee

on Standards Policy, and included costing guidelines initially developed under the guidance of the Office of the NASA Comptroller.

However, due to the exigencies of reorganization, and the proposed NASA Metrication Assessment Study, a NASA Notice, NN8010, The International System of Units, February 6, 1978 was issued. The notice provides interim guidance for one year. The salient points are:

NASA will use the SI:

- (1) In concert with the National Metrication Program
- (2) As availability emerges in industry
- (3) Where contractor or grantee activities are conducted in metric
- (4) Where a specific need exists, e.g., in metric interface hardware
- (5) Where there is a definite economic, operational or other significant advantage

#### IV. NASA METRICATION ACTIVITIES SINCE 1964

As early as 1964 NASA recommended in the NASA Publications Manual, SP-7013, the use of SI units. Authors and writers were required to use SI if SI units posed no difficulty in the interpretation of results, and parallel usage if difficulty was anticipated by SI units alone. Also in 1964 NASA published The International System of Units, SP-7012, as a guide for aerospace units. In 1975, the second revision of SP-7012 was issued.

Of greater significance, in 1964, was the work for conversion to use of the metric system at the Marshall Space Flight Center (MSFC) under the auspices of Werner Von Braun. The formal plans, policy statement, and training for metrication were shelved at MSFC even though the U.S. standards of weights and measures were metric standards and had a statutory basis, because the rest of the country had not even begun to consider overall metric usage. It is somewhat ironic that the same visionary people who did so much to advance man's efforts in space, also were so far ahead in their perception of the need for the use of SI, a far simpler system than those in general use in the United States at that time.

NASA's participation from 1968 to 1971, with the Department of Commerce in conformance with the Metric Study Act of 1968, is a matter of record in NBS SP 345-2, one of thirteen interim reports forwarded by the Secretary of Commerce to the Congress in 1970-71. It was during this period that the initial (and interim) organization for reporting on metric conversion was established. During this same period NASA, under the direction of the Deputy Administrator, formulated the policy on use of SI in technical reports which culminated in the issuance, in 1970, of NPD 2220.4 (see para. 3, above), and initiated the practice of using SI in Congressional presentations and news releases.

In 1974, metrication was placed under the Office of Industry Affairs and Technology Utilization, and responsibility for the program was assigned to the Low Cost Systems Office. Between 1974 and 1976, the Low Cost Systems Office initiated action on and coordinated many activities in the establishment of metric specifications and standards. The Marshall Space Flight Center was given the responsibility of providing representation to the Department of Commerce/National Bureau of Standards Interagency Screw Thread Committee, and to the Society of Automotive Engineers, which had become the U.S. leader in the development of metric standards, particularly for fasteners.

In 1976, the Deputy Director of the NASA Headquarters Scientific and Technical (STI) Office was appointed the NASA Metric Coordinator. This followed immediately on the signing of the Metric Conversion Act in December 1975, and a request in early 1976 by the Secretary of Commerce for the appointment of a NASA member to the Metrication Subcommittee of the Interagency Committee on Standards Policy (ICSP). NASA responded by changing its representation to the ICSP from that of observer to full membership, and appointing the new NASA Metric Coordinator as a member of the Metrication Subcommittee.

Beginning in 1976, NASA established its internal organization for metrication coordination (see para. II, above), initiated action on preparation of metrication policy (see para. III, above), and began to formulate the metrication assessment requirements. In this latter endeavor, acknowledgement is made of the superb coordination and excellent assistance provided by personnel of the Goddard Space Flight Center, the Langley Research Center, the Marshall Space Flight Center, and the NASA Scientific and Technical Information Facility.

In 1977, NASA published its first comprehensive metrication bibliography as a NASA Technical Memorandum. The bibliography was prepared by personnel at the Marshall Space Flight Center. Its comprehensive coverage, quality, and utility are attested to by the many requests and complimentary remarks that have been received as a result of its publication.

During this period NASA also provided representation to the U.S. Metric Association, the American National Metric Council (ANMC) and the Aerospace Industries Association.

#### V. FEDERAL AGENCY ACTIVITIES

NASA metrication coordination with the Federal Departments and Agencies has been carried out primarily through the Metrication Subcommittee of the ICSP, which provides the locus for interaction between the metric coordinators of the various agencies. Perhaps the greatest interactions have been with the Departments of Agriculture, Commerce, Defense, Energy, Interior, and Transportation, and the Small Business Administration.

In addition to participation in Metrication Subcommittee activities, NASA also appointed its Metric Coordinator to serve as a member of the

Executive Board of the Subcommittee. Accomplishments of the Subcommittee to date are:

- (1) Preparation of the Subcommittee charter
- (2) Advising the ICSP of the need for a high-level Metrication Policy Committee
- (3) Preparation and adoption by the Federal Agencies of guidelines for preparation of agency metrication policy directives
- (4) Preparation and adoption of procedures for establishment and operation of "Divisions" of the Subcommittee
- (5) Establishment of Eight Divisions and One Working Group:
  1. Metric Practices and Preferred Units Department of Commerce
  2. Transportation Department of Transportation
  3. Construction Department of Defense
  4. Regulatory and Legal Department of the Interior
  5. Energy Department of Energy
  6. Awareness and Training Civil Service Commission (tentative)
  7. Consumer Affairs Department of Agriculture
  8. Procurement and Supply and one Department of Defense  
Information Working Group Department of Agriculture
- (6) Preparation and adoption of guidelines for Federal Agency interaction with non-Federal Agency metrication activities
- (7) Interpretation of the requirements of PL75-168 on the Federal Agencies

In addition to the cooperative efforts with the Federal Agencies through the Metrication Subcommittee, close coordination has been maintained with the Department of Defense and the Federal Aviation Administration (FAA) on aerospace metrication. Both NASA and DOD participated with the FAA in the FAA Consultative Planning Conference on November 15, 1976, on Aviation Metrication. The cooperation NASA has received in aerospace metrication from both agencies and from the DOD on programs for metrication of specifications and standards has been exemplary.

#### VI. NONGOVERNMENTAL METRICATION ACTIVITIES

NASA's participation in nongovernmental metrication activities has been carried out primarily in conjunction with four organizations involved in metrication, the U.S. Metric Association, the American National Metric Council, the Aerospace Industries Association and the Society of Automotive Engineers. Because of the long and close association between personnel at the Marshall Space Flight Center (MSFC) and the U.S. Metric Association, NASA has relied on MSFC to continue to provide the liaison and representation, with Headquarters involvement only on an as-needed basis. The relationship with the U.S. Metric Association has been most constructive, informative and rewarding.



NASA, like other Federal Agencies, provides direct representation to the American National Metric Council via the NASA Metric Coordinator. In addition, NASA provides representation to the Engineering Coordinating Committee directly from the Office of the NASA Chief Engineer, to the Construction Industries Coordinating Committee from the Office of Facilities, and to the Aerospace Sector Committee by the NASA Metric Coordinator. Representation to the Aerospace Sector Planning Committee and the four Aerospace Subsectors is provided by two teams, one from the East Coast comprised of personnel from Headquarters and the Goddard Space Flight Center, and the other from the West Coast comprised of personnel from the Ames Research Center (which provides West Coast coordination), and the Jet Propulsion Laboratory. This arrangement results from the fact that the Aerospace Sector Committee holds two national meetings each year, one on the East Coast and the other on the West Coast. It also permits a greater direct participation and awareness by NASA personnel on metrication in aerospace and aerospace-related areas.

The Aerospace Industries Association (AIA) provides the Executive Secretariate for the Aerospace Sector Committee and for the International Standards Organization Technical Committee (TC) 20 on Aerospace. NASA representation to the AIA has involved three areas: (1) the ASC previously discussed, (2) the National Aerospace Standards administered by the AIA, and (3) the ISO standardization activities with point-of-contact being in the Office of the NASA Chief Engineer. NASA Headquarters has agreed to provide the meeting site for the 1978 international meeting of the ISO TC 20, which is being held this year in the United States.

For many years, NASA participation with the Society of Automotive Engineers (SAE) has been through the Marshall Space Flight Center particularly in their standardization endeavors. Since 1977 the Headquarters point-of-contact for the SAE has resided in the Office of the NASA Chief Engineer.

Like the relationship with both the U.S. Metric Association and the ANMC, the relationship with the AIA and the SAE has been most rewarding and exemplary. With industry providing the leadership and the personnel through these, and other, representative organizations, it should not be surprising that the U.S. metrication endeavors have been able to make such progress. In international metrication, to any casual observer, if anything raises a specter of horror to the British, it is the fact that even though the United States started about ten years later than the British, the Americans just might beat the British in completion of the metrication changeover.

NASA also has been the recipient of the experience of metrication in the U.S. automotive industry. American Motors, General Motors, Chrysler Corporation, the Ford Motor Company and the International Harvester Corporation have been most generous in sharing their experience and know-how, particularly during the 1976 in-house review of NASA metrication activities. Of particular merit has been the ability of the automotive industry and its 40,000 suppliers to effect such a smooth

transition particularly in so large an endeavor without dislocations in the national economy.

Last but not least the Aerospace Industry has been most cooperative in sharing its metrication know-how with NASA. The problems of metrication within the aerospace industry are somewhat different from that of the automotive industry because of the relatively long-life span (30 to 40 years) for aircraft. In addition, because of the interdependency of the aircraft industry for its components and sub-assemblies, the metrication of aviation alone is far more complex than might be expected at first glance. This is especially critical in the area of aviation flight and safety. Like the automotive industry, the aerospace industry has been most generous in sharing its metrication expertise, not only with NASA but with the other Federal Agencies. This has been particularly true in the activities of the Aerospace Sector Committee of the ANNC. NASA is particularly pleased to acknowledge the contributions of the Boeing Commercial Airplane Company, McDonnell-Douglas Corporation, Northrop Corporation, Gruman Corporation, and the General Dynamics Corporation.

#### VII. NASA METRICATION ASSESSMENT STUDY

The inception of the metrication assessment study began in 1975. In the review of NASA metrication activities, at that time, four questions were posed:

- (1) What legislation pertaining to metrication was still on the statute books?
- (2) What is the status of metrication in the other Federal Agencies and in the public and private sectors?
- (3) What is the status of metrication in NASA?
- (4) What should be the content and thrust of a NASA metrication program, and what is the estimated cost?

The NASA Metrication Assessment Study is intended to provide answers to questions 3 and 4.

The content of the study and its organization were developed in conjunction with the NASA Headquarters metrication representatives. Twenty-two activities were identified and defined, and provision was made for the NASA Centers to add new activities with the requirement that any added activities be defined. The twenty-two activities are:

<u>Item</u>	<u>Activity</u>
1.	Safety
2.	Real Property and Facilities Planning
3.	Facilities Design and Construction
4.	Facilities Operations and Maintenance
5.	Research/Technical Facilities Operations
6.	Aircraft Operations
7.	Automated Data Processing
8.	Systems Design and Development
9.	Space Flight
10.	Research Activities



<u>Item</u>	<u>Activity</u> (continued)
11.	Development Activities
12.	Hardware Systems Engineering (Design and Development)
13.	Administration and Management
14.	Procurement and Contracting
15.	Legal
16.	Reliability and Quality Assurance
17.	Awareness and Training
18.	Public Affairs
19.	Applications
20.	Tracking and Data Acquisition
21.	Health
22.	Personnel Operations

The activities are to be reported in terms of five functional/operational categories:

- (1) Operational System, Application or Procedure
- (2) Documentation, Reference and Records
- (3) Equipment Requirement
- (4) Tools and Aids Needed
- (5) Supplies Required

The study is organized into four sections: (1) Technical and other Factors, (2) Awareness and Training, (3) Cost, and (4) A Specification and Standards Inventory. Section I requires a discussion of what the overall NASA program should be, at the international, national and interagency levels, and the areas in aerospace metrification in which NASA should play a leadership role; and a discussion of the Center's program, where they have a specific expertise, and where and why they should assume a leadership role.

The awareness and training requirement is to address the basic questions of: (1) who is to be trained (general orientation and top management; clerical and administrative; scientists, engineers and other professionals; trades and shops; and intermediate managers and supervisors); (2) what the training programs should consist of, and (3) how the training is to be effected.

The cost section is to cover metrification over a time-frame of 1, 2, 3, 4, 5, 6-10, and 11-15 years assuming a base year of FY 1981. The year 1981 was chosen as a point of departure for uniform cost comparison and has no other significance.

The specifications and standards inventories cover: the NASA specifications, standards, procedures, handbooks, etc., recommended for metrification, as well as the Military, Federal, National, International and industrial standards that should be invited to the attention of the proponent organization as a candidate for metrification. Because of the direct cost of metrification and the indirect cost of the confusing proliferation of specifications and standards, it will be necessary that NASA cooperate in a national effort to standardize to the extent practicable. The Centers' lists will be consolidated for review, and a plan will be

implemented to reduce unnecessary redundancy and overlap.

If the study is undertaken during the current year, the report should be ready for release in late 1978 or early 1979.

#### VIII. SUMMARY AND CONCLUSION

This report has addressed the six areas that highlight NASA Metrification and related activities. The overriding guideline is that NASA should keep pace with the national effort. For NASA to proceed either too fast or too slow in its metrification efforts is to incur or cause unwarranted costs to others.

Metrification at best is a synchronized, cooperative endeavor involving participants at all levels. From a national point-of-view, it is evident that the metrification effort has been slowed by the delay in the establishment of the U.S. Metric Board. However, it is heartening to note that the cooperative efforts between government, industry and the private sectors have provided the mechanisms for metrification to move forward on an area-by-area and an industry-by-industry front. That most sectors have participated cooperatively, freely and openly at all levels, on a voluntary basis is indeed a tribute to American enterprise, spirit and ingenuity. That the United States will become a metric nation is inevitable, and much of the credit for smoothing and ameliorating the impact of metrification will be due to a continuation of the open, voluntary and cooperative spirit that has been effected by all segments of this Nation. The Metrification Session of WESTEC '78 is but one manifestation of this truly American phenomenon.

#### Acknowledgement

The author wishes to acknowledge the assistance of Mr. Philip F. Eckert, Informatics Information Systems Company, for the critical review and editorial assistance in the preparation of this report. Mr. Eckert has served as a consultant and technical assistant for NASA metrification activities from 1976 to date.